RDECOM

U.S. Army War College
Strategic Implications for Emerging Technologies
XX Annual Strategy Conference
15 April 2009
Panel I: Biotechnologies: Genetic Engineering & Molecular Biology

Institute for Collaborative Biotechnologies

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Institute for Collaborative Biotechnologies (ICB)

To identify and study fundamental mechanisms underlying

the high performance and efficiency of biological systems

and to translate these results to engineered systems

Awarded to UCSB in 2003; renewed in 2008

- **Alliance of UCSB, Caltech, MIT with Army & Industry Partners**
- **Interdisciplinary R&D (molecular biology, chemistry, physics, engineering) at the interface between biotechnology & engineering**
- **FY09 budget: 6.1 - $9.5 M**
  6.2 - $4.0 M
- **Mission: Accelerate Army transformation through biotechnology**

ICB

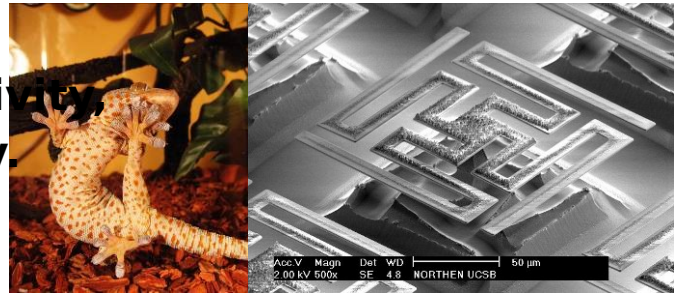
UCSB

Massachusetts Institute of Technology

Institute for Collaborative Biotechnologies (ICB)

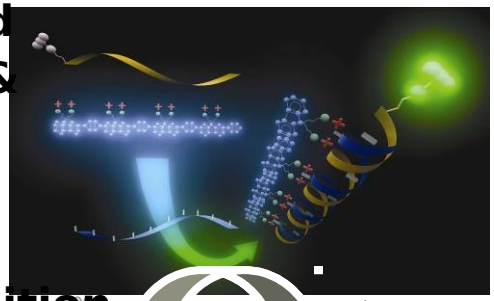
Biomolecular Sensors

Biosensor platforms with unprecedented sensitivity, reliability, durability, compactness, integrability.



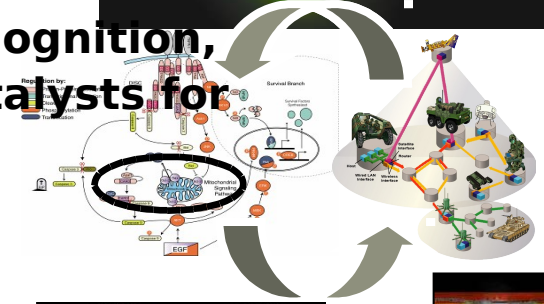
Materials and Energy

Use of biological and bio-inspired approaches toward synthesis of improved electronic, magnetic, optical & energy-dispersive materials.



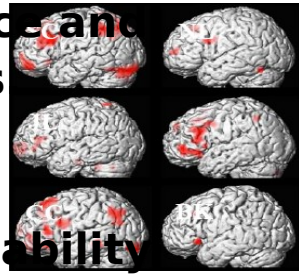
Biotechnological Tools

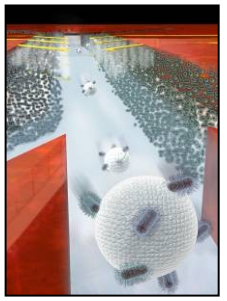
Development of biotechnologies in molecular recognition, signal transduction, molecular self-assembly, catalysts for energy processes.



Bio-Inspired Network Science

Multi-scale modeling/simulation of the performance and properties of biological components and networks





Cognitive Neuroscience

Study of the neural basis of individual soldier variability using brain imaging, genomics and modeling.

Microfluidic SELEX Technology

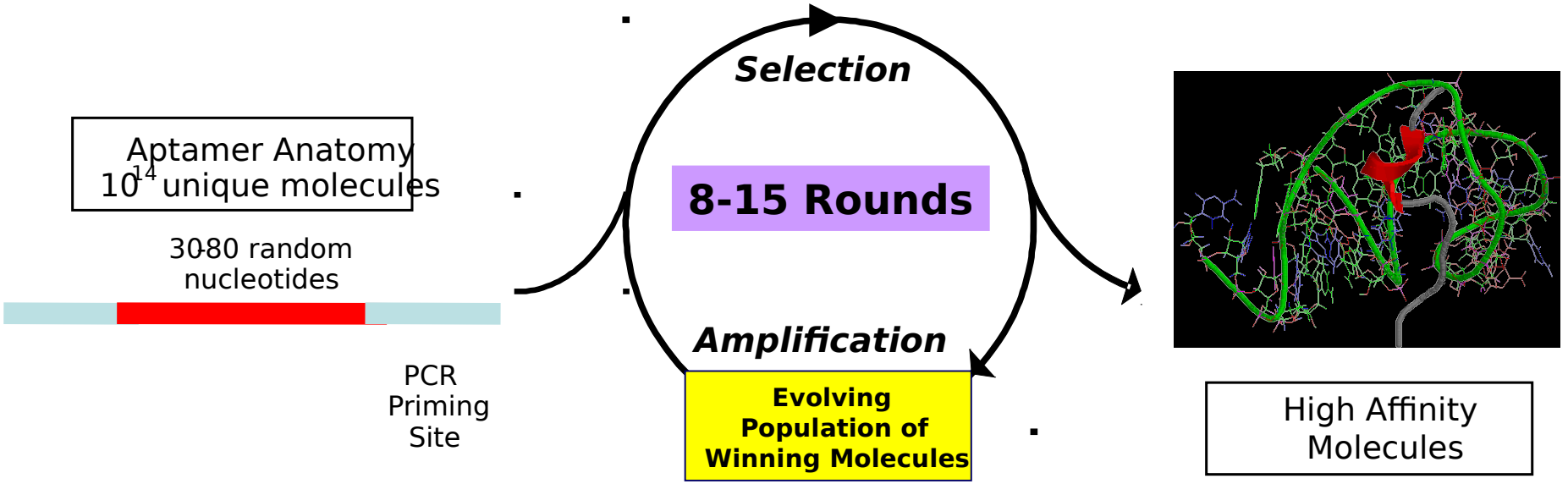
Prof. H. Tom Soh, UCSB

Objective

- **Develop ultrahigh efficiency, microfluidic SELEX system capable of rapidly generating specific, high-affinity reagents (DNA aptamers).**

Impact

- **The technology to generate DNA aptamers "on-demand" will allow capability to respond rapidly to new Chemical and Biological threat agents.**



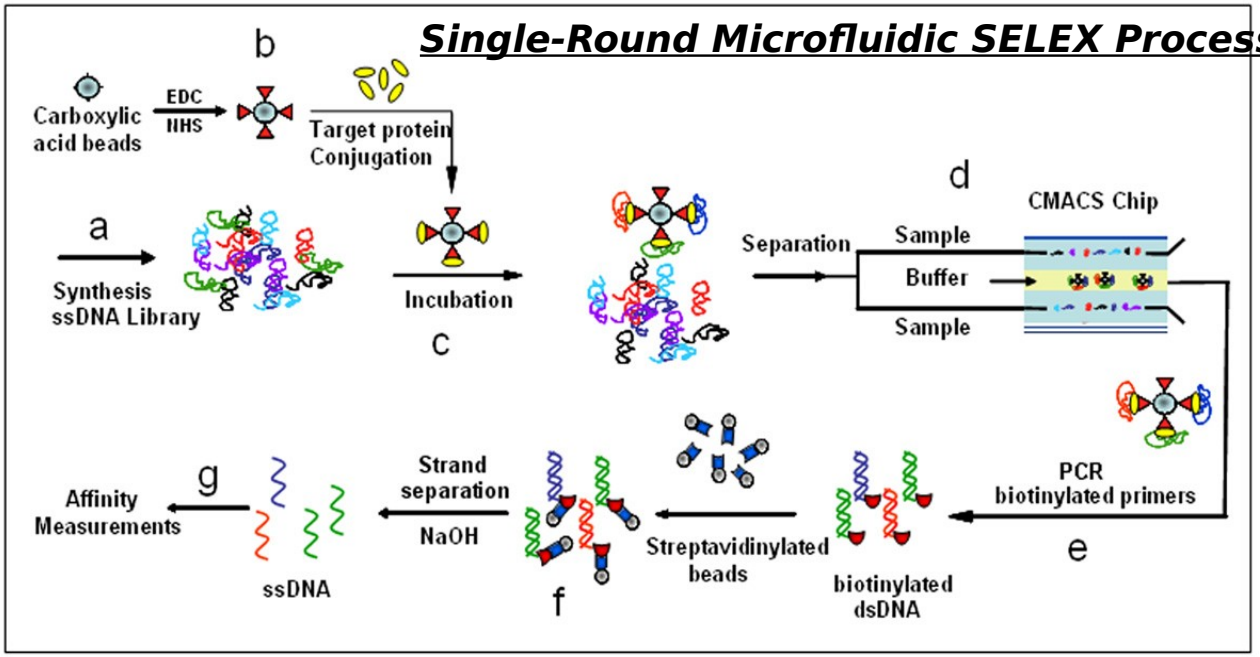
Microfluidic SELEX Technology

Prof. H. Tom Soh, UCSB

Accomplishment

- **Utilizing ultrahigh purity microfluidic separation devices, PI demonstrated extremely rapid, single-round generation of high affinity DNA aptamers.**

Single-Round Microfluidic SELEX Process



Lou, X., et al. PNAS (2009) 106: 2989-2994.

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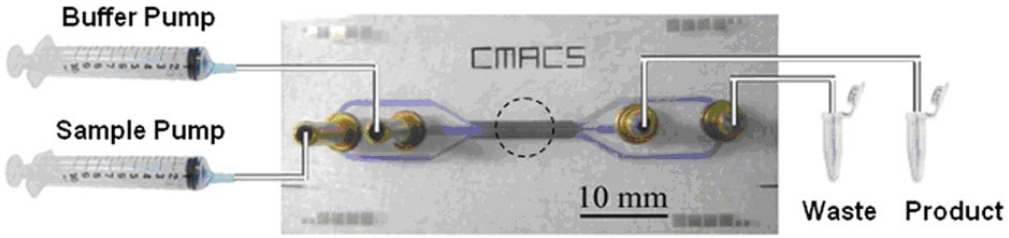

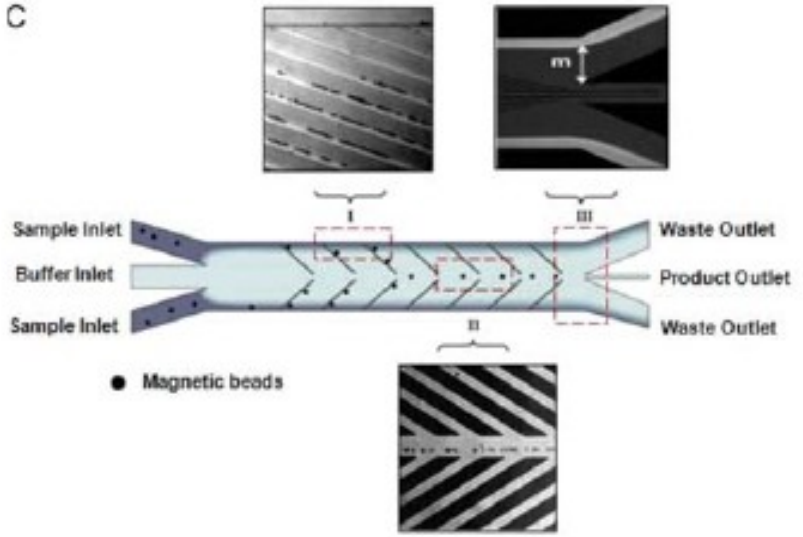

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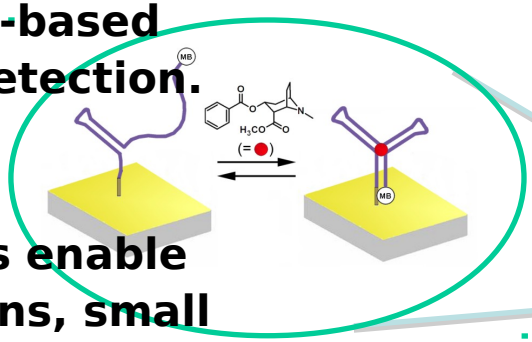
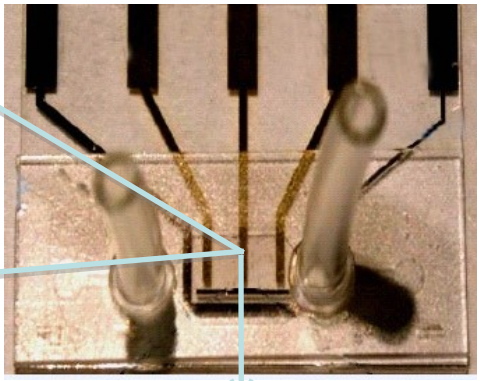
Electronic Sensors for Rapid Detection of Threat Agents

Prof. Kevin Plaxco, Alan Heeger, H. Tom Soh UCSB

Objective

- **Development of electronically-based sensing platform for biological detection.**



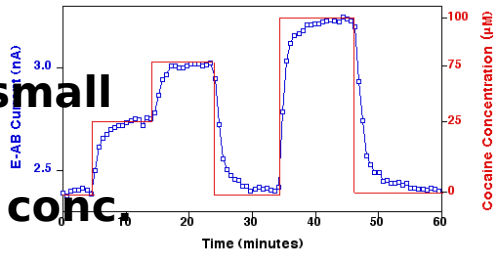


Impact

- **Aptamer recognition elements enable detection of nucleic acids, proteins, small molecules, inorganic ions**

Accomplishments

- **Smart electrode surfaces allow real-time detection of small molecule analytes**
- **Device integration: Real-time detection of μM cocaine conc. in flowing, undiluted blood serum**
- **Successful 6.2 transition to ARL-SEDD, Nanex LLC**

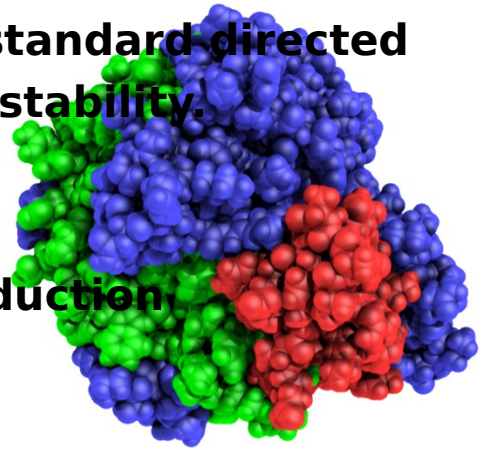


Improved Cellulases by Structure-Guided Recombination

Prof. Frances Arnold, Caltech

Objective

- **Apply SCHEMA recombination and modeling approach to improving a class of enzymes, cellulases, that cannot be improved via standard directed evolution methods. Focus is on enhanced enzyme stability.**



Impact

- **Addresses need for distributed in theater fuel production by utilizing cellulosic field waste.**

Accomplishments

- **Constructed 23 novel, active cellulases with a wide range of thermostabilities.**
- **The most thermostable cellulase has thirty times longer half-life at 63 C than that of the most thermostable parent cellulase.**
- **Generated model to predict many chimeric sequences that have even higher thermostabilities.**

Non-Canonical Amino Acids in Protein Engineering

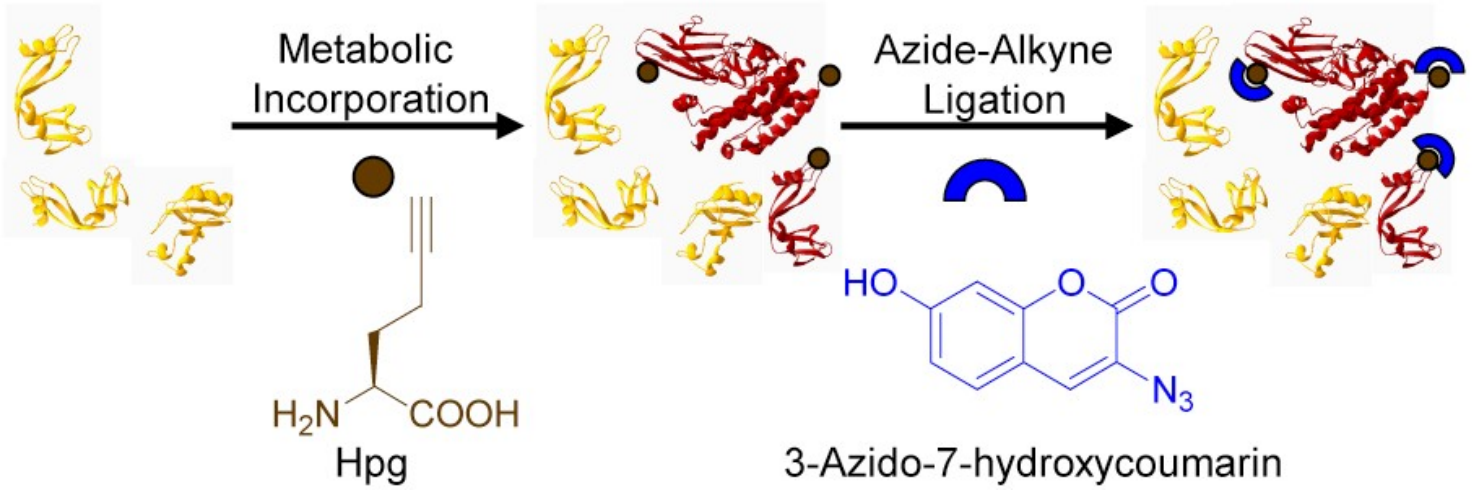
Prof. David Tirrell, Caltech

Objective

- **Exploit the chemistry of non-canonical amino acids to develop new apporaches to protein design, evolution and analysis**

Impact

- **Provide new method for the study of host-pathogen interactions**

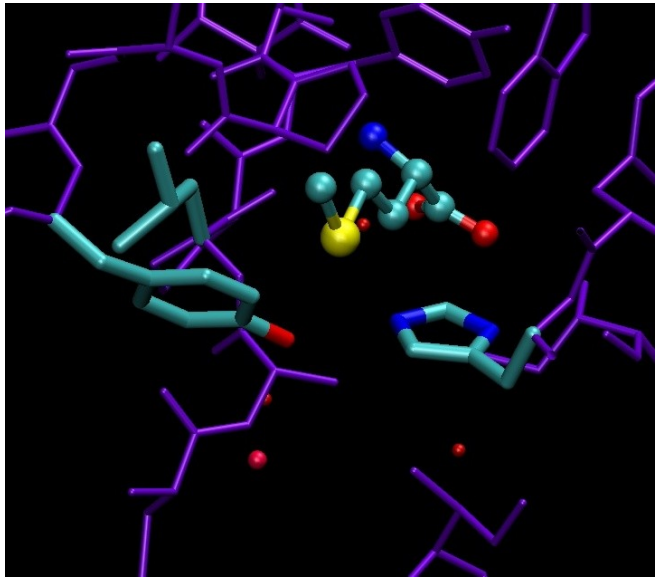


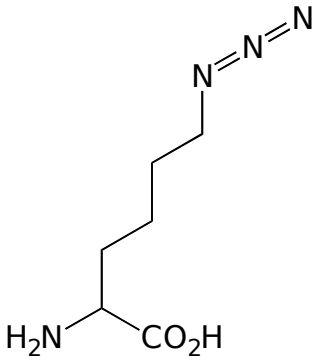
Non-Canonical Amino Acids in Protein Engineering

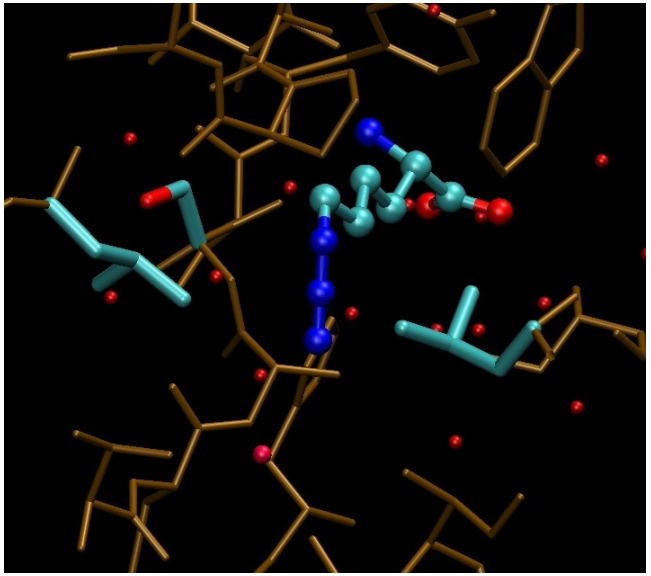
Prof. David Tirrell, Caltech

Key Accomplishments

- **Determination of crystal structure of methionyl-tRNA synthetase variant that activates azidonorleucine (Anl) for protein labeling**
- **Demonstration of cell-selective protein labeling in mixed bacterial cultures and in mixtures of microbial and mammalian cells**







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Phage Display

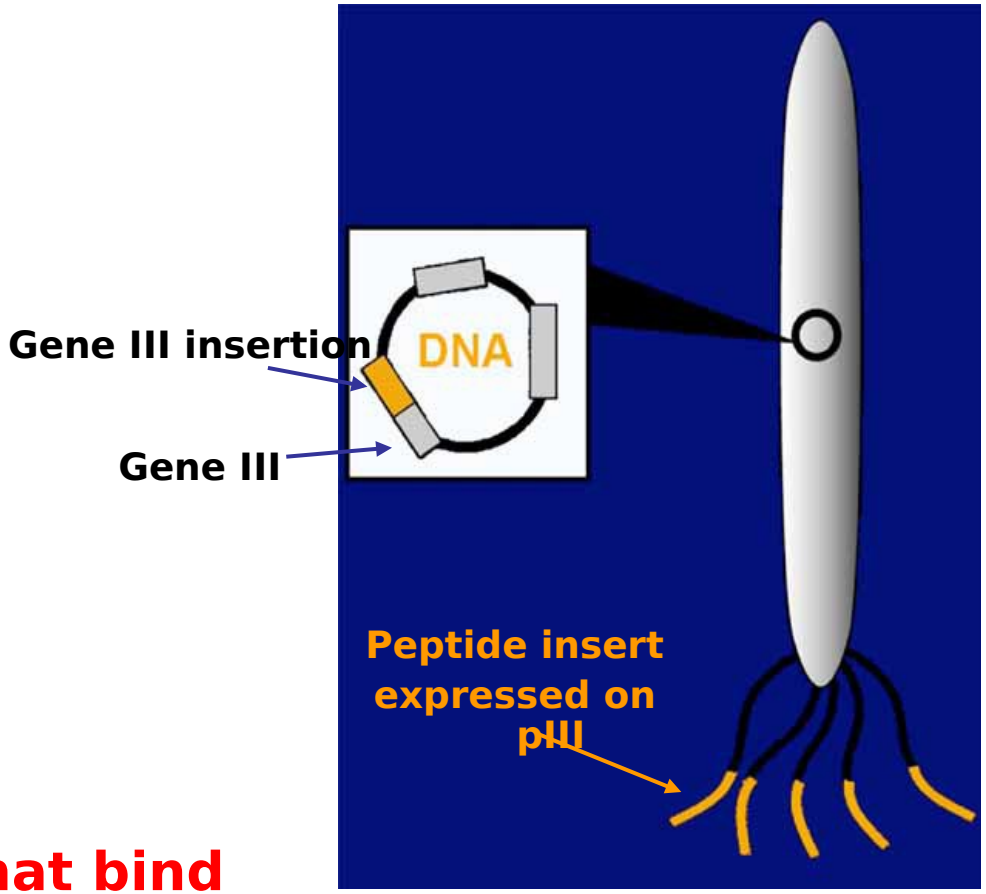
- Method for studying protein-peptide and DNA-peptide interactions.

- Large library of phage containing randomized insertions in phage gene encoding pIII is generated.

- Library is incubated against desired target; unbound phage are washed away.

- Bound phage are eluted and enriched by recycling.

- Enriched peptides are sequenced

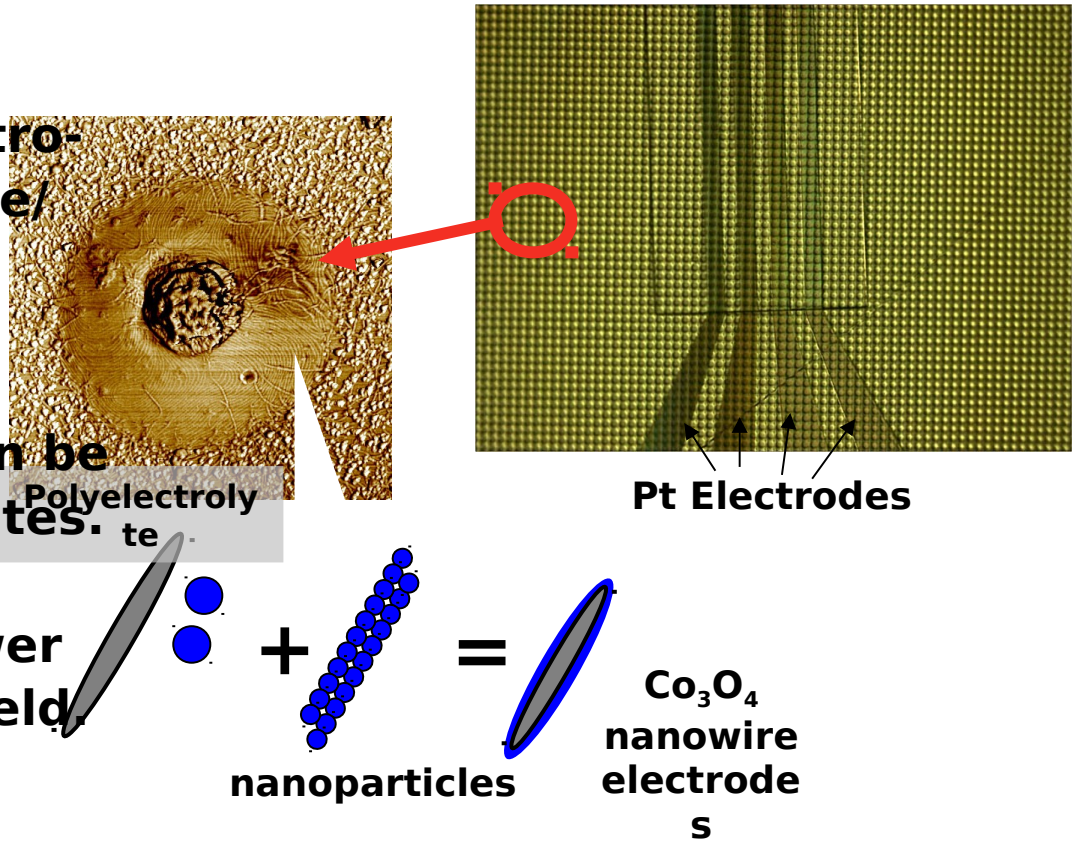


Screen for peptides that bind inorganic battery materials!

Stamped Microbattery Electrodes Based on Self-Assembled M1

Prof Angela Belcher, MIT

- **Electrodes exhibit full electro-chemical functionality (voltage/ capacity, discharge capacity, cylcing stability).**
- **Microbattery electrodes can be stamped onto flexible substrates.**
- **Potential for providing power for sensors in uniforms and field.**



Nam, et al., PNAS (2008) 105:17227-1723

Institute for Collaborative Biotechnologies (ICB)

Institute for Collaborative Biotechnol

University of California at Santa Barbara working

- Academic Partners (Caltech, MIT)
- Army Partners (ARL, RDECs, MRMC)
- Industrial Partners

To accelerate the pace of Army transformation through biotechnolog

2008 Metrics and Accomplishments

- 53 ICB faculty
- 49 post-docs supported
- 95 graduate students supported
- 33 faculty honors and awards
- 38 doctorates awarded
- 8 inventions disclosed
- 118 peer-reviewed publications